To: Plan Preparers

From: Stormwater, Dams, & Agricultural Permitting Section

Revision Date: 7/30/2010   **Original Date:** 6/14/2006

Re: Outlet Structure Calculations using SEDCAD

Revised Memo

The Department has recently been advised that the manufacturers of SEDCAD have released multiple builds of SEDCAD, which have added additional modeling options (i.e., enhance perforated riser). For this matter, a revised memo was requested to be release on how the Department will review these new options.

For new projects or revisions received after **September 1, 2010**, based on the information provided by the SEDCAD Website, DHEC's Stormwater Permitting Section will begin checking that all SEDCAD orifice design calculations using the "*Enhance Perforated Riser*" option are based on the **orifice invert elevation** and not the centerline elevation. Unlike the "*Perforated Riser*" option, both large and small orifices can be modeled without the need of user-inputted data when using the "*Enhanced Perforated Riser*" option.

For all stormwater designs that include the use of the "*perforated riser*" option, the Department recommends the use of only relatively small orifice (diameters of 3 inches or less). For perforated risers that have orifice diameters that are larger than 3 inches the design professional must use the "user-input" option and provided hand calculated discharges that were inputted into SEDCAD. More details on this option are provided in the original memo attached below.

In addition to the above, all SEDCAD calculations submitted to the Department for approval must **use the NRCS 241 pt Distribution option** located on the Storm Information Section under the Design Tab.

Please ensure that your version of SEDCAD is kept up to date. **The current SEDCAD Build Number is 2010.04.09**. Please update your version by the directions provided on the SEDCAD Website.

Original Memo (June 6, 2006)

The Department has recently come across information that changes the way we review SEDCAD calculations for outlet structures.

For new projects or revisions received after **June 15, 2006**, based on the information below, DHEC's Stormwater Permitting Section recommends that only relatively small orifices (diameters of 3 inches or less) are entered when a perforated riser structure is selected as a discharge option using SEDCAD. **Handcalculated user-input discharges must be used when orifice diameters are larger than 3 inches.** User-input discharges must be calculated from the permanent pool or pond bottom elevation to the top of the dam and must include, at a minimum, the riser structure and all corresponding orifices, weirs, and outlet pipe.

Below is an explanation from Pamela Schwab, a developer of SEDCAD, on how to design orifices for outlet structures. Keep these suggestions in mind when designing orifice flow with SEDCAD. Questions submitted by the S.C. DHEC Stormwater Permitting Section are shown in italics.

Please keep in mind that we are only providing this information in reference to how we will be reviewing SEDCAD calculations. Any questions about SEDCAD should go to Pamela Schwab at Sedcad@cs.com or Dr. Richard Warner from the University of Kentucky at rwarner@bae.uky.edu.

From Pamela Schwab, Developer of SEDCAD

Should orifices with diameters greater than 3" be entered for a perforated riser?

"Even though the routine has been designed for *orifices*, we have experienced people using 6" or even 12" hole diameters. In those situations, the orifice flow equation provides an approximation and the thin plate weir relationships, derived through the equation for sharpcrested rectangular weirs by mathematical integration of elemental orifice strips over the nappe, is more applicable. Anticipating such needs, SEDCAD4 has the capability for the user to input a stage-discharge relationship that could be used for the larger holes. Users may approximate the stage-discharge relationship for larger holes using the orifice flow equation embedded within SEDCAD4, but it should be understood that it is an approximation. **Holes in the 4 to 6-inch range, typical for ponds used in sediment control, can be approximated** in such a manner whereas for holes larger than 8 inches consideration should be given to independently calculating the stage-discharge values and entering them into SEDCAD4 through the user-input option."

How should or can equivalent orifice sizes be entered and at what elevation(s) should they be entered? For example, a perforated riser has 1-2" orifice at 100' and 3-3" orifices at 102'. How should this be entered?

"If there is one 2" hole at 100' and three 3" holes at 102', I would recommend input of equivalent hole diameters. Viewing the orifice flow equation above, it can be seen that the cross-sectional area should be used for equivalency. Since SEDCAD4 expects the same number of holes per elevation, I would recommend entering three holes per elevation and entering a diameter that would be the equivalent area of the 2" hole. Assuming 3 holes/elevation, my calculations show that you would enter a diameter of 1.154" in place of a single 2" hole.

Similarly, for a square or rectangular hole, in a circular riser, I would approximate the circular hole on an equivalent areas basis. For larger square or rectangular openings, the equation for sharp-crested rectangular weirs by mathematical integration of elemental orifice strips over the nappe is more applicable."

How should the equivalent diameter be calculated for a square or rectangular riser structure (e.g., 4'x4' box with outer dimensions of 4'x4' and inner dimensions of 3'x3') so the correct flow through the top of the riser is calculated when entering in Sedcad as a perforated riser?

"If you are using the Perforated Riser routine, I would use the 3'x3' value since the riser could not hold any more water than that equivalent area. However, know that SEDCAD4 assumes a sharp entrance at the top of the riser as well as the orifices, and not necessarily a 6" lip at those places. I assume a 3'x3' interior and 4'x4' exterior implies a 6" lip all around.

This would result in an equivalent Riser Diameter of about 40.6 inches:
3'x3' = 1296 sq in
$1296 = .25 * Pi * D_2$
D = about 40.6 in

You might also consider some hand calculations to generate a user-defined discharge curve. You could use the Broad Crested Weir flow over 12'-16' of width, but check that the total flow could be carried by a "pipe" of the 3'x3' size. The orifices could also be generated by hand and combined into the user-defined rating curve. Compare some of these calculations with the Perforated Riser routine, so that you can make a value judgment on the applicability of the PR to your situation.

Once the water reaches the top of the riser, SEDCAD4 calculates all of Weir, Orifice, and Full Pipe flow, and chooses the least discharge value for each stage value. As the stage (head) increases, the flow control will change through each of these characteristics.

Also with regard to Perforated Risers, once flow is reached above the top of the riser, the flow through the holes is considered to be negligible as compared to that flowing over the top of the riser. Once flow over the riser is larger than flow through the holes (usually immediately), the flow through the holes is ignored since its conditions are likely unmet (esp. atmospheric conditions in center of pipe).

I would still suggest using the equivalent area (40.6 in), because it will be that pipe area

which will constrict the flow once it reaches the top of the riser (Weir, Orifice, Full Pipe flow). Weir flow usually only occurs for very shallow heads, before it transforms into Orifice and Full Pipe flow."

"We are working on expanding SEDCAD4 capabilities to provide more automatically generated stage-discharge values for a wider spectrum of spillway configurations including large holes, squares, rectangular slots, multiple slots and would welcome your input regarding additional spillway configurations that DHEC and/or your clients my need in the future.

I have discussed your questions with my co-developer, Dr. Richard Warner at the University of Kentucky (rwarner@bae.uky.edu or 859-312-8956). He has essentially provided the above responses and concurred with my suggestions."